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(54) Method for transferring, between two switching exchanges for mobile services, the handling of an active connection with a mobile terminal.

(57) To transfer the handling of an active connection being handled by a first switching exchange connected to the exchange equipped for fixed telecommunication to a base station associated with another switching exchange, a connection is made between the first and the other switching exchange and a connection is made between said other switching exchange and the base station associated therewith, which base station reserves a radio channel for the mobile terminal, after which the communication with the mobile terminal is taken over by said base station; a connection is also made between the exchange equipped for fixed telecommunication and the other switching exchange and, after the connection to the mobile terminal has been taken over by the base station, the entire handling of the connection is taken over by the other switching exchange and the connection between the two switching exchanges, and between the first switching exchange, and the exchange equipped for fixed telecommunication, is disconnected.

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sake of completeness, it is further pointed out in this connection that, although the object of the invention is to provide a method which can be advantageously used in GSM, the use does not have to be limited to GSM but is also possible in other mobile telecommunication systems.

For this purpose, the invention provides a method of the abovementioned type in which a connection is also made between the exchange equipped for fixed telecommunication and the other switching exchange, and in which, after the connection to the mobile terminal has been taken over by the base station associated with the other switching exchange, the entire handling of the connection is taken over by said other switching exchange and the connection between the two switching exchanges and between the first switching exchange and the exchange equipped for fixed telecommunication, is disconnected.

C. REFERENCES

- M. Meijer, Network Aspects of the RACE Mobile Telecommunications System
Annual Conference RACE 1043, Cambridge, 23-25 January 1989;
- GSM Rep 03.09, version 3.0.0, 15 February 1988

D. EXEMPLARY EMDODIMENTS

The invention will be illustrated in more detail by reference to the drawing in which:

Figure 1 shows a diagrammatic representation of the structure of a GSM network:

Figure 2a-b shows a diagrammatic representation of a known handover procedure in a GSM network;

Figure 3a-d shows a diagrammatic representation of the handover procedure according to the invention;

Figure 4 shows a very general diagrammatic representation of a mobile telecommunication system, and

Figure 5 shows a flow diagram of the method according to the invention.

Figure 1 shows diagrammatically the structure of a GSM network. Such a network is composed of a pluraiity of mobile stations (MS) which represent the terminals, for example the telephone sets, of the mobile subscribers. Each mobile station can be connected via a radio path to a base station (BS) which is a transceiver unit having a working area with a limited range, a so-called cell. Every mobile station which is located inside the cell of a particular base station and has an active connection is in contact with said base station via a radio connection. One cell may contain a plurality of mobile stations having an active connection, all the said mobile stations therefore being connected to the same base station. A plurality of base stations is associated with a mobile switching exchange (MSC) which is a local exchange such as those also encountered in fixed telecommunication networks and which contains, inter alia, the switching functions supplemented by the specific functions which are necessary in order to be able to operate mobile telecommunication. One MSC therefore has a working area which comprises all the cells of the associated base stations.

A data base (DB) is connected to the mobile switching exchanges and contains the data which relate to the mobile aspects of the GSM system. Finally, a transit exchange (TX), which is a exchange such as is also used in fixed telecommunication systems such as ISDN, is provided. Said exchange contains switching functions and the like. A plurality of MSCs is connected to one TX. The TX is connected in turn to a conventional fixed telecommunication network which is not shown.

If an MS moves from one cell, for example the working area of BS 1.2, to another cell, for example the working area of BS 2.1, said MS will have to be connected to the base station that is associated with said new cell. An existing active connection will therefore have to be rerouted to the new base station while the connection is active so that no interruption occurs. This rerouting is termed "handover". During handover, the situation may occur that a mobile station moves from the working area of one base station to another base station, for example from base station 1.1 to base station 1.2, which are both associated with the same mobile switching exchange in this case MSC1. This situation will not be discussed in the present case in view of the fact that the GSM proposal for this type of handover already offers a satisfactory solution. The present application relates exclusively to the case where a mobile station moves from the cell of a base station associated with the first mobile switching exchange to the cell of a base station associated with a second mobile switching exchange, that is to say, for example, from BS 1.2 to BS 2.1 in Figure 1.

The controlling functions which are important for a handover procedure are, in particular, "call control" and "handover control". In the GSM system said functions are assigned to the mobile switching exchange which initially handles the active connection from TX to MS.

Figure 2 shows diagrammatically the progress of the handover procedure according to the existing GSM proposal. Figure 2a shows the initial situation in which MSC1 is the mobile switching exchange which is originally included in the connec-

of two phases, the first phase corresponding virtually completely to the handover procedure according to GSM described above and the second phase resulting in the restoration of the shortest route between TX and MS1.

As will emerge below, in the handover procedure according to the invention, the transfer of the "call control" function from one MSC to the other is also necessary. For this purpose, a new handover control unit (HCU) which deals with the totality of control related to the handover and the signalling associated therewith is introduced into the GSM network. Said HCU is not a physical unit but a functional unit which may be present, for example, in every MSC.

Figure 3a shows diagrammatically the GSM network at the beginning of a handover procedure according to the invention. The handover control unit HCU has a signalling connection to the TX and to the mobile switching exchanges MSC1 and MSC2. For the sake of simplicity, the database DB which is in fact necessary is not shown in Figure 3, while the HCU is not shown either in Figure 3b-d. If MS1 moves from the cell associated with BS 1.2 to the cell of BS 2.1, the handover procedure initially proceeds in a manner comparable with the steps 1 to 4 inclusive which have been illustrated above with reference to Figure 2a, b. After the expiry of step 4, the diverse connections shown in Figure 3b are achieved. Up to and including said 4th step it does not matter whether the handover control unit HCU is imagined to form part of MSC1 or is seen as a separate unit. The only difference from the handover procedure described above is that a call control function is reserved in MSC2 during the second step. Said function is synchronised with the call control function of MSC1. From the instant that this synchronisation has been achieved, both call control functions continue to be active, the call control in MSC1 having a "master" function and therefore actually taking the decisions, while the call control in MSC2 has a "slave" function and therefore has no authority to take decisions. After the situation shown in Figure 3b has been reached, the handover procedure according to the invention proceeds as follows:

Step 5: the HCU signals that a connection has to be set up between MSC2 and TX, for which purpose a bridge which couples the connections TX-MSC2 and MSC2-MSC1 and also MSC2-BS 2.1 to one another is installed in MSC2. The connection between TX and MSC2 is related by the TX to the active connection which already exists. The situation now obtained is shown in Figure 3c.

Step 6: the TX can now switch over from the connection TX-MSC1 to TX-MSC2.

Step 7: HCU signals that the call control in MSC2 has to take over the actual call control of the call control in MSC1 and from now on, the connection is therefore controlled by the MSC2 call control, to which the MSC1 call control is no longer relevant.

Step 8: finally, the call control function in MSC1 and also the connections TX-MSC1 and MSC1-MSC2 will be cleared. The bridge which was present until then in MSC2 is removed and the connections TX-MSC2 and MSC2-BS 2.1 will be connected through. The situation then obtained is shown in Figure 3d. It is evident from this figure that, owing to the handover procedure according to the invention, the shortest route is again achieved between TX and MS1 after the expiry of said procedure. Figure 4 shows a very diagrammatic representation of a mobile telecommunication system in which the block X represents a primary fixed telecommunication system, for example an ISDN network, having connections X1 to X3 inclusive. The fixed telecommunication system is connected via said connections to mobile switching exchanges MSC1 to MS3 inclusive, each having a plurality of outputs Y. An HCU and a DB which have the same function as described above are furthermore provided. The MSCs are connected via the Y connections to the transceiver system Y which is connected via a radio route to the terminal system Z. Referring to Figure 4, the handover procedure according to the invention can be described functionally as follows, it being assumed that, for an existing active connection, the configuration of the connections extends from Xi via Yi.k ultimately to a mobile station in the system Z. If it is further assumed that the handover takes place from connection Yi.k to Yj.1, where i ≠ j, the handover procedure results in

Step 1: setting up of the connection MSCi-MSCJ.

Step 2: setting up of the connection Yj.l to, ultimately, MS.

Step 3: setting up of the connection Xj between the primary telecommunication system and MSCj.

Step 4: switching over of connection Yi.k to Yj.l by, ultimately, the MS.

Step 5: switching over of the primary telecommunication system from connection Xi to Xj.

Step 6: installation of a "bridge" between the connections Xi, Yi.k and MSCi-MSCj in MSCi.

Step 7: connecting through of the connections Xi and MSCi-MSCj in MSCi, the "bridge" thereby being removed.

Step 8: installation of a "bridge" between the connections Xj, Yj.l and MSCi-MSCj in MSCj.

Step 9: connecting through of the connections Xj and Yj.l in MSCj, the "bridge" thereby being removed.

Step 10: reserving of slave "call control" in

MSC2. the "bridge" therefore being removed. and clears the old radio channel. A confirmation of the through connection and the clearing is sent to the HCU by MSC1 by means of the "free radio channel accept" message.

In order not to arrive at a conflict situation with the protocol of the SS no. 7 used. MSC2 has to generate an answer signal, the "ANSWER" message. when the "HB-CONFIRM" message has been received.

If the connection between MSC1 and MSC2 cannot be set up. which will be indicated in a message other than the "ACM" message. this is transmitted to the HCU which then terminates the handover procedure.

The HCU sends a "channel TX MSC2" message to the TX. The TX then prepares to set up a connection from the TX to MSC2. which is illustrated by the "IAM" message. After MSC2 has received said "IAM" message. it sends an "ACM" back and "couples" the connection set up with the TX to the connections between MSC1 and MSC2 and the connection between the MSC2 and the "new" BS. This is done by means of a "bridge". An "ANSWER" message is then sent to the TX. After the "ANSWER" message has been received. the TX switches from the connection which runs from the TX to the MSC1 to the connection which runs from the TX to MSC2. After this switch-over, an indication thereof is sent to the HCU. which is illustrated by the "channel TX MSC2 accept" message.

In order to stop the procedures related to handover. the HCU sends "end signal" reports both to the TX. MSC1 and MSC2. The TX then clears the connection between the TX and MSC1 by despatching a "RELEASE" message. MSC1 will then clear the connection between MSC1 and MSC2. whereupon MSC2 removes the "bridge" and will connect through the connection between TX and MSC2 and the connection between MSC2 and the BS.

As shown in the flow diagram of Figure 5. the handover procedure also contains the transfer of call control from MSC1 to MSC2. In the handover flow diagram the following is therefore assumed:

- if MSC1 sets up a connection between MSC1 and MSC2 by transmitting the "IAM" message. the present state which the call control function is in is sent concomitantly. MSC2 will then reserve a call control function and synchronise. From this instant onwards there are there fore two call control functions. one in MSC1 and one in MSC2. which are in parallel. However. the call control function of MSC1 retains the actual control and can be seen as the "master". while the call control function of MSC2 is the "slave":
- all the messages which are related to call control and are received by MSC1 from the TX before the latter has switched over from the connection between the TX and MSC1 to the connection between the TX and MSC2 and from the "old" BS. as well as all the actions which are possibly undertaken by the call control function are transmitted to MSC2. so that the "slave" control function is able to remain synchronous:
- all the messages which are related to call control and are received by MSC1 from the TX after the latter has switched over from the connection between the TX and MSC1 to the connection between the TX and MSC2 and from the "new" BX are transmitted to MSC1 which consequently continues to receive all the call control messages and is able to remain the "master".

In this state. it holds true that the call control function contained in MSC1 is totally dependent on the transmission of the call control messages by MSC2.

HCU will ultimately initiate the actual transfer of call control by despatching the "take over control" message to MSC2. MSC2 will then take over the call control. MSC2 will no longer transmit any call control messages to MSC1 but. on the contrary. will transmit a "transfer call control" message to MSC1. MSC1 then clears its call control function and sends a confirmation of this to MSC2 by means of the "transfer call control accept" message.

After the actual takeover of call control. MSC2 sends a "handover report" message to the database DB in order to update the present location of the MS if appropriate. MSC2 finally reports the call control takeover to the HCU by means of the "take over control accept" message.

Claims

1. Method for transferring the handling of an active connection made to a mobile terminal between two switching exchanges equipped for mobile services in a telecommunication system equipped for mobile communication. comprising at least one mobile terminal (MS). a plurality of base stations (BS) equipped for communication via a radio path with the mobile terminal and each having a working area with a limited range. at least two switching exchanges (MSC) equipped for mobile services and each being able to interact with a specific group of the plurality of base stations. and a exchange (TX) equipped for fixed telecommunication which is able to interact with the switching exchanges in which method. to transfer the handling of an active connection made. with the mobile terminal which is being handled by a first switching exchange which is connected to the exchange

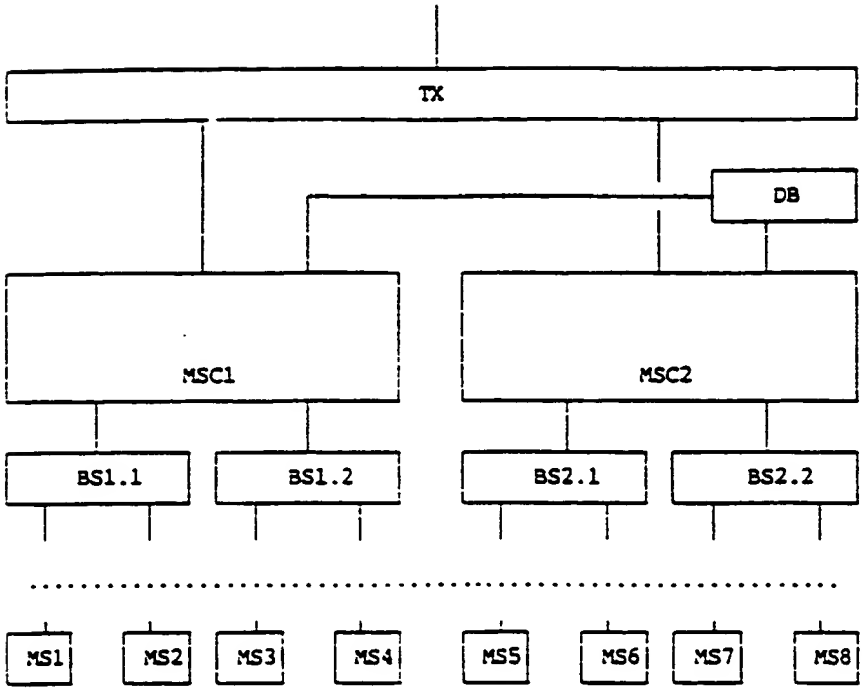
TX
DB
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1
MS2
MS3
MS4
MS5
MS6
MS7
MS8

FIG.1

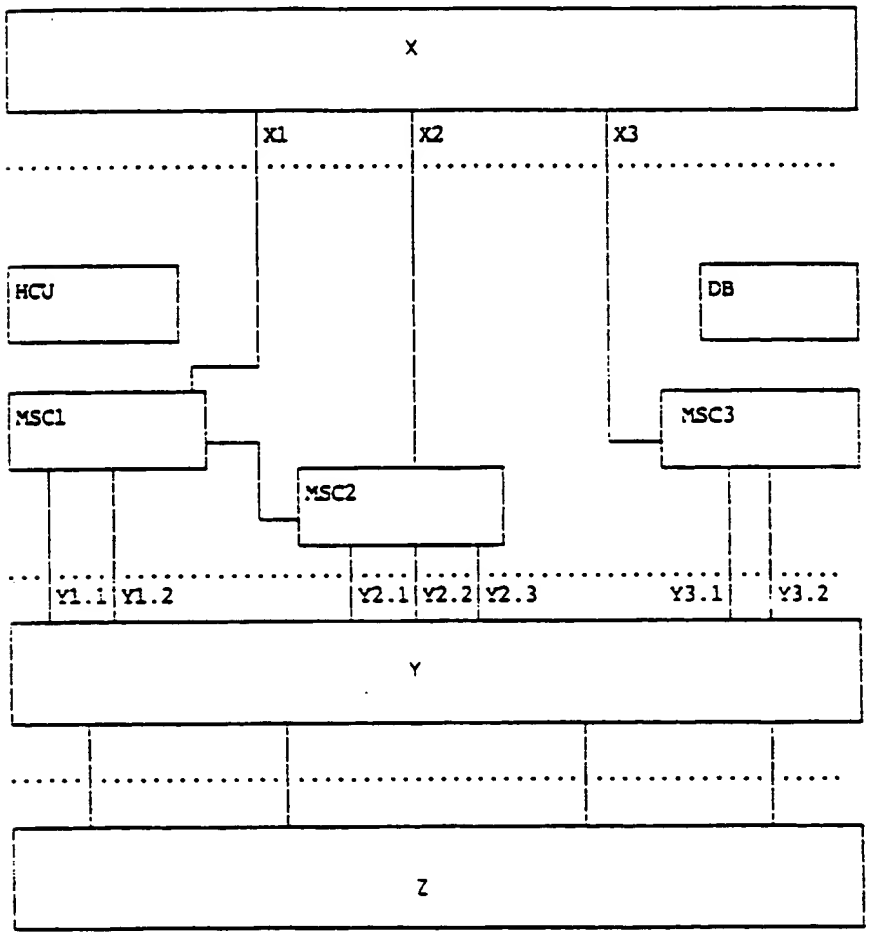
X
X1
X2
X3
HCU
DB
MSC1
MSC3
MSC2
Y1.1
Y1.2
Y2.1
Y2.2
Y2.3
Y3.1
Y3.2
Y
Z

FIG.4

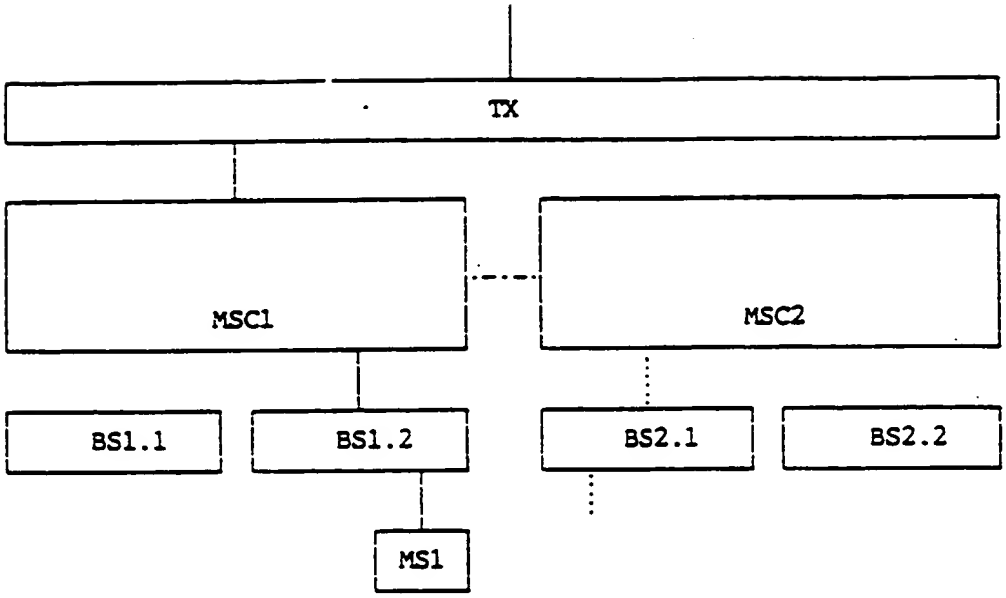
TX
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.2a

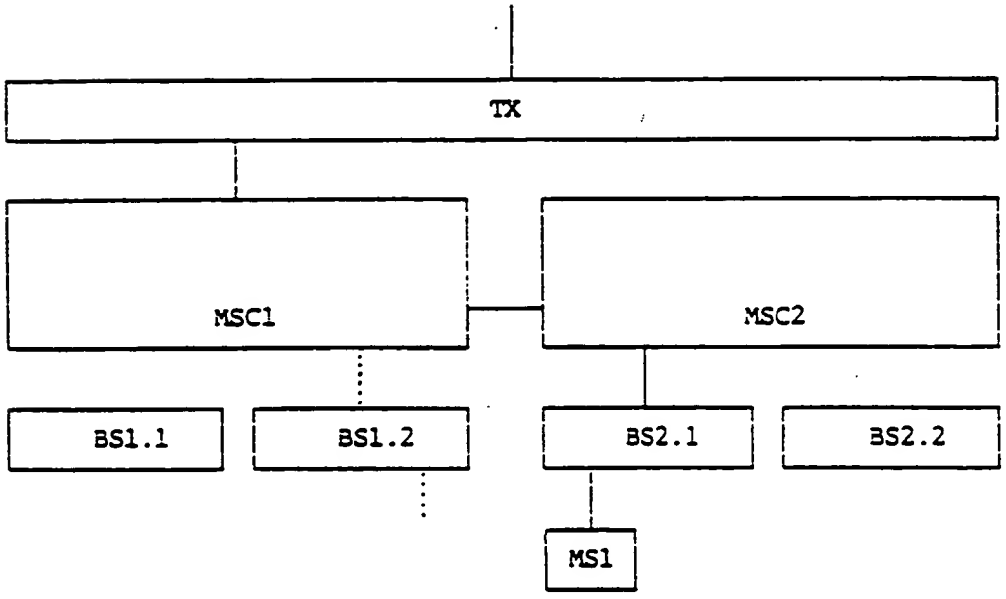
TX
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.2b

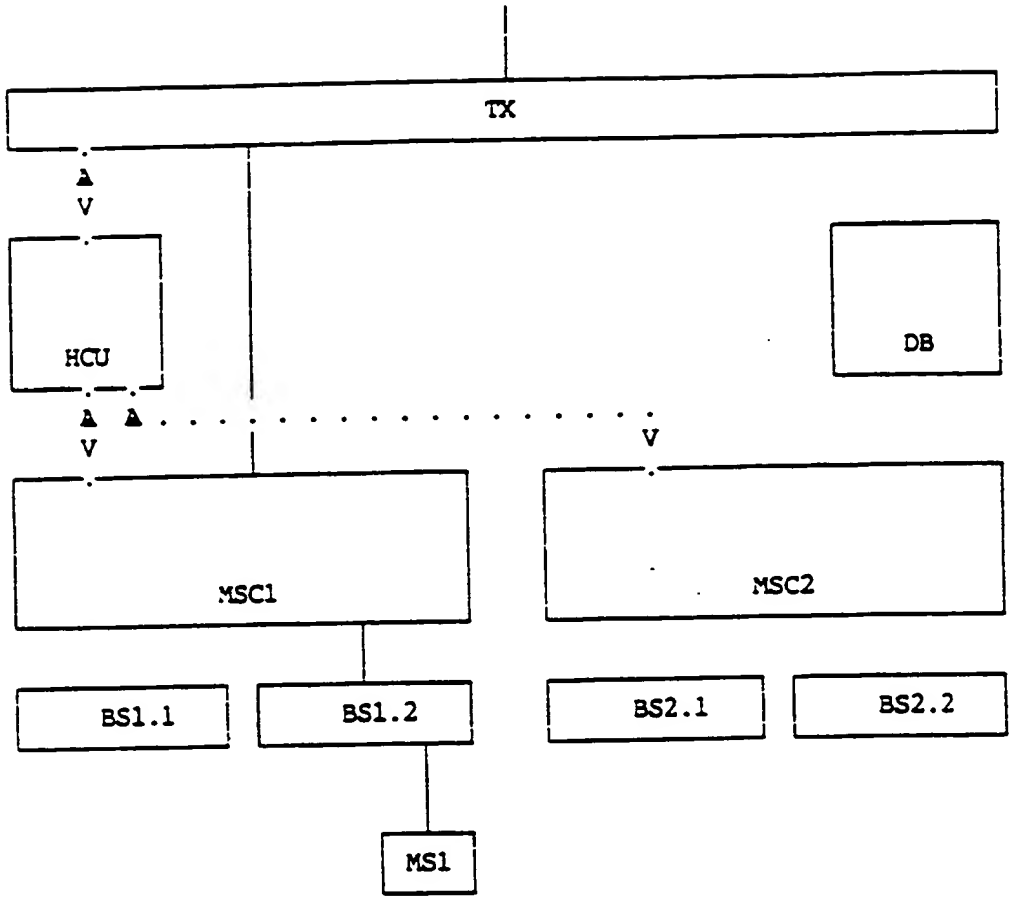
TX
V
HCU
DB
V
V
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.3a

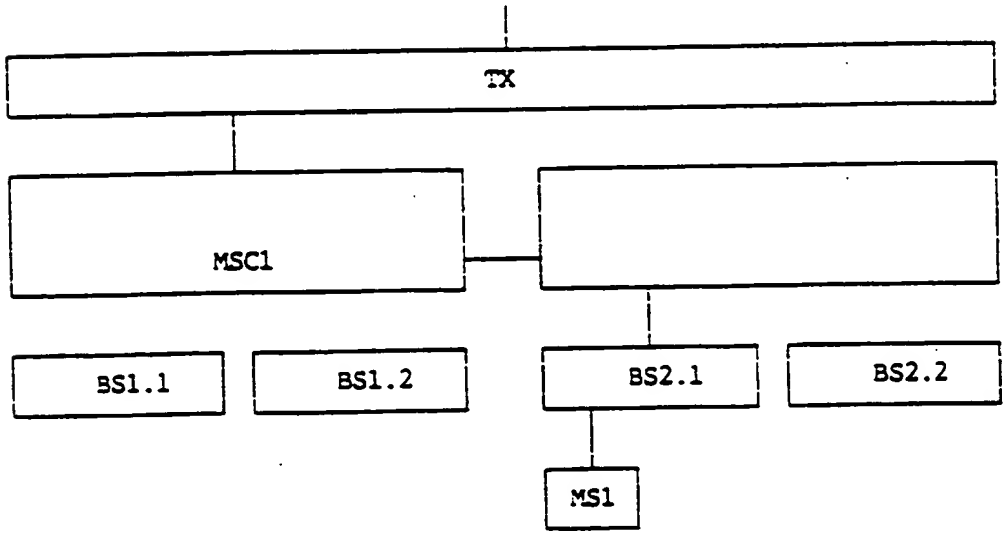
TX
MSC1
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.3b

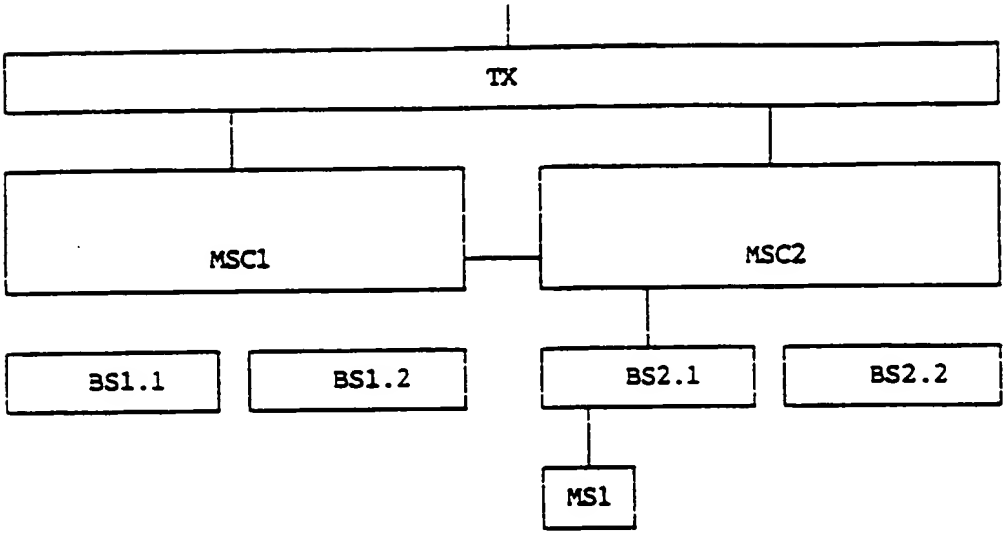
TX
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.3c

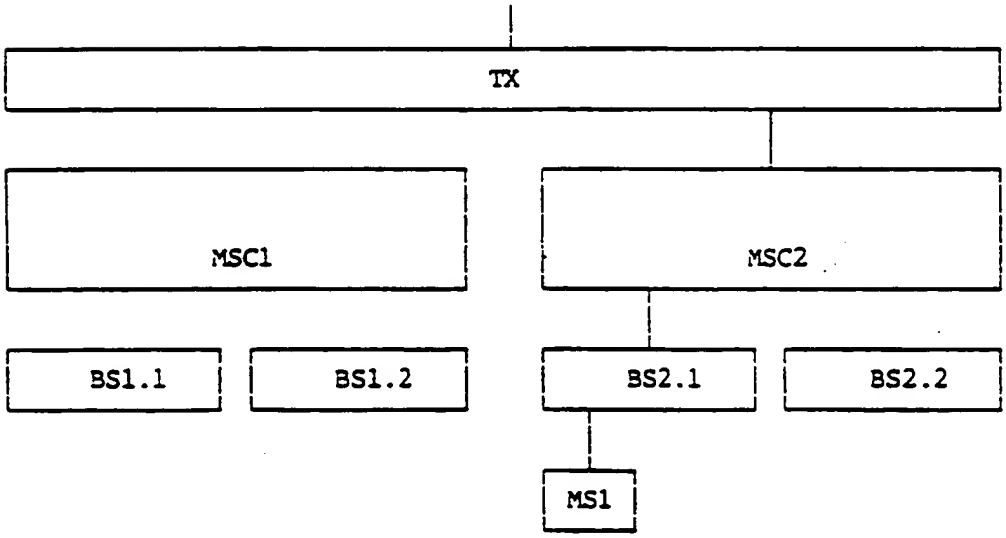
TX
MSC1
MSC2
BS1.1
BS1.2
BS2.1
BS2.2
MS1

FIG.3d

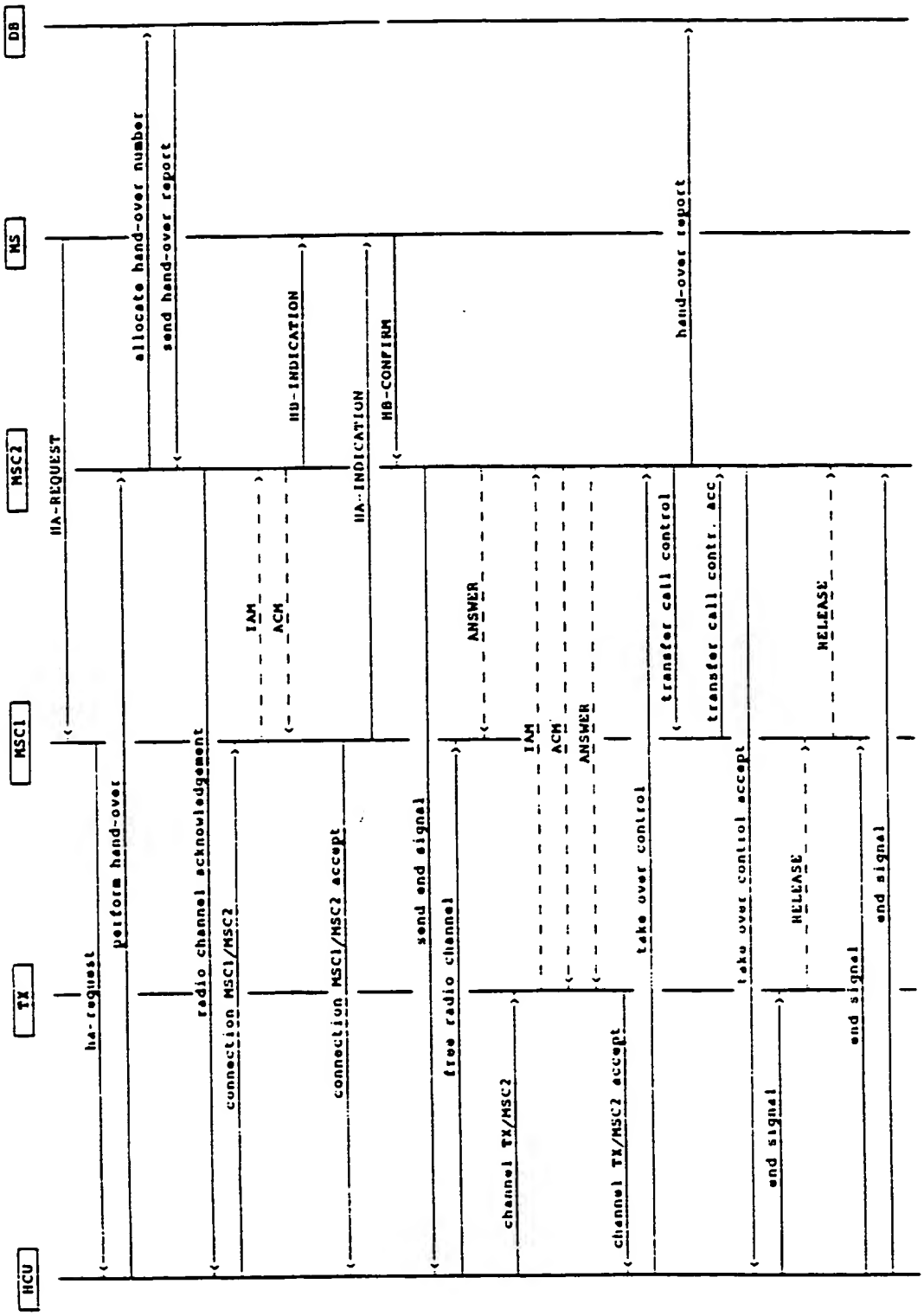
HCU
TX
MSC1
MSC2
MS
DB
ho-request
HA-REQUEST
perform hand-over
allocate hand-over number
send hand-over report
radio channel acknowledgement
connection MSC1/MSC2
IAM
ACM
HB-INDICATION
connection MSC1/MSC2 accept
HA-INDICATION
HB-CONFIRM
hand-over report
send end signal
ANSWER
free radio channel
IAM
ACM
channel TX/MSC2
ANSWER
channel TX/MSC2 accept
take over control
transfer call control
transfer call contr. acc.
take over control accept
end signal
RELEASE
RELEASE
end signal
end signal

FIG.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 20 2591

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	GLOBAL TELECOMMUNICATIONS CONFERENCE ,NOV.15-18. 1987. vol. 3, TOKYO (JP) pages 1583 - 1588; A.NAKAJIMA et al: "Enlarging Technologies Based On No.7 Signalling System For Mobile Communication Network" * page 1584, paragraph 2.3 - page 1588, paragraph 6. *	1,2	H 04 Q 7.04
Y	Commutation & Transmission no. 4, 1988, PARIS (FR) pages 17 - 30; M.BALLARD et al: "ECR 900 La Radiotéléphonie Numérique Européenne d'ALCATEL." * page 18, middle column, line 21 - page 23 *	1,2	
A	EP-A-0 281 111 (N.T.T) * column 1, line 25 - column 3, line 42 * * column 4, line 12 - column 10, line 23 *	1,2	
A	36th IEEE Vehicular Technology Conference,20-22 May,1986 DALLAS (US) pages 304 - 310; G.D. CULP: "Cellular Intersystem Handoff: Creating Transparent Boundaries." * the whole document *	1,2	
A	Proceedings of the International Switching Symposium ,May 7-11, 1984 ,Session 32B,Paper 4, AMSTERDAM (NL) T. GOTO et al: "Nation-Wide Automobile Telephone Service Using Tracking Exchange Technology " * page 4, paragraph 2.2 - page 6, paragraph 3 *	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H 04 Q

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	04 January 91	GERLING J.C.J.

CATEGORY OF CITED DOCUMENTS

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